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MODULAR GAUGE BLOCK ASSEMBLY WITH SECURE LATERAL PINS

[0001] This application is a continuation-in-part of U.S. patent application Ser. No. 10/075,645 filed February 13, 2002 which is a continuation-in-part of U.S. patent application Ser. No. 10/038,219, filed January 3, 2002 which is incorporated in its entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to replaceable self-aligning gauge modules for a tufting machine and is more particularly concerned with gauge modules with individually replaceable gauge elements which can be readily installed and removed.

BACKGROUND OF THE INVENTION

[0003] Tufting machines are built with precision so that the needles and loopers of the machine are accurately spaced from each other along the needle bar or looper bars. The loopers and needles must be spaced from each other so that the looper bills pass closely adjacent to the needles to engage and hold loops of yarns carried by the needles. When assembling a tufting apparatus, errors in positioning these gauge elements may accumulate as the work progresses. The present invention seeks to establish consistency with these parts across the width of the apparatus, to provide a tufting environment, suitable

even for narrow gauge configurations. The present invention also addresses the problem of replacing individual gauge elements that become broken or damaged during tufting. In most modular designs, a broken gauge element requires discarding the entire modular block containing a set of about one to two dozen gauge elements. The present invention allows for quick and efficient replacement of individually damaged gauge elements.

[0004] The idea of replacing individual components of assemblies in tufting machines is not new. In the past, knife holder assemblies have been devised that allow for the replacement of individual knives. The knives were arranged in pre-assembled or modular fashion in a knife holder, each knife holder having a guide mechanism which enabled groups of knives, each group in a separate holder, to be positioned on a carrying member of a tufting machine and maintained in appropriate alignment. U.S. Patent Nos. 4,608,934; 4,669,171; 4,691,646; and 4,693,191 illustrate such prior art knife holder assemblies in which parallel knives are disposed. These prior art knife holder assemblies are then disposed in transverse bars provided with guides for positioning the holders in appropriate positions on a tufting machine.

[0005] Needles have previously been individually secured in modular gauge blocks as shown in U.S. Patent No. 4,170,949, and hooks and knives have also been individually secured in

gauge parts mounting blocks as shown in U.S. Patent No. 4,491,078. These designs have used individual clamping screws to hold each gauge element in place. These blocks were not mated with slots on the carrying members and were heavily machined. In addition, the clamping screws used in these gauge blocks have typically been flat ended and have relied upon the flat tip pushing directly against the gauge element to securely position those gauge elements. When the blocks are machined from relatively soft metals such as aluminum, there has been a tendency for the threads of the block to become worn and allow too much play for all of the screws to securely hold their corresponding gauge elements.

[0006] More recently attempts have been made to incorporate needles and loopers into replaceable modular blocks. U.S. Patent Nos. RE37,108, 5,896,821, 5,295,450 illustrate such modular gauge assemblies in which the gauge elements are permanently embedded into the modular block. The block is attached to the guide bar with a single screw allowing for removal and replacement of the block. One shortcoming of these modular blocks is that when a single gauge element breaks the entire modular block must be discarded.

SUMMARY OF THE INVENTION

[0007] The present invention includes a modular gauge assembly that attaches to a gauge bar. The gauge bar has a

plurality of positioning recesses that allows a detent on an individual modular block to be accurately positioned along the gauge bar. Each modular block typically includes a front surface, a pair of side surfaces opposed to each other, a rear surface opposite to the front surface, and a bottom surface.

[0008] A tongue, which may or may not be a part of the cast block extends from a rear or bottom surface of the modular block. The tongue includes a threaded hole which along with a securing screw serves to mount the block to a gauge bar. The threaded hole aligns with the gauge bar receiving hole when the tongue of the modular block is positioned properly with a recess on the gauge bar. When sufficiently tightened, the securing screw holds the modular block to the gauge bar. Alternatively, the block may be positioned with pins fitting into recesses in the block and gauge bar.

[0009] At least the front surface of the block contains a plurality of spaced parallel slots so that gauge elements may be positioned in the slots with proper spacing. The proximal ends of the gauge elements may have apertures or channels recessed therein. In one embodiment of the present invention the proximal ends of the gauge elements are inserted into the block and secured there by a lateral pin that enters the block on one of the opposing side surfaces and passes through apertures on the proximal ends of the gauge elements. One

alternative embodiment allows the pin to be placed by forming a channel in the block. Another alternative embodiment biases a lateral pin resting in a channel on the proximal ends of the gauge elements by tightening a securing bolt that is in communication with the lateral pin through an opening on the block. The securing bolts may have conical ends or flat ends depending upon their orientation with respect to the lateral pin to exert a wedging or camming force against the lateral pin. In either case the gauge elements are secured by a lateral pin engaging the gauge elements. Individual gauge elements can be replaced by demounting the affected block, removing the lateral pin and removing a selected gauge element. After the selected gauge element is removed a new gauge element may be re-inserted into the proper vertical slot and secured by the lateral pin and securing bolt.

[0010] A plurality of modular blocks are arranged along the surface of the gauge bar and are vertically positioned on the gauge bar by a horizontal surface of the gauge bar or of a guide bar that passes through a guide bar channel on the gauge bar. The width of each block is substantially equal to the distance between the positioning recesses of the gauge bar so that the edges of the blocks abut one another and the blocks are laterally positioned.

[0011] In an alternative embodiment of the present invention each modular gauge assembly attaches to a gauge bar having a plurality of positioning recesses that allows the detent on the individual modular block to laterally position the block on the gauge bar. Each modular block typically includes a front surface, a pair of side surfaces opposed to each other, a rear surface opposite to the front surface, and opposing bottom and top surfaces. The rear surface contains a rectangular tab or detent that includes a threaded hole to receive a securing screw. The threaded hole aligns with the gauge bar receiving hole when the modular block is positioned properly on the gauge bar. When tightened, the securing screw holds the modular block securely to the gauge bar. A plurality of gauge holes extend from the bottom toward the top surface, in some cases passing through the modular block. Gauge elements with proximal ends adopted to be received within the gauge holes may be positioned with proper spacing in the block. Gauge elements that have the proximal end inserted into the block are securely positioned by pin-screws that enter the block below the tab on the rear surface. The pin-screws are positioned beneath the tab. In this fashion, the pin-screws can be accessed without removing the modular block from the gauge bar. When engaging rounded gauge elements such as tufting needles, the pin screws may

advantageously have conical ends to hold the gauge elements by wedging or camming force.

[0012] Of particular advantage is the use of lightweight aluminum alloys such as aluminum 7075 from which to manufacture modular blocks. When these modules are utilized with aluminum alloy or other lightweight material hook bar brackets, jack shaft rockers, and hook shaft drive levers, approximately 40% of the weight of these components, comprising some 200 pounds across the length of a broad loom tufting machine, can be removed from the moving action of the machine. This reduction in weight tends to correspondingly reduce the vibration of the tufting machine and facilitates operation of the tufting machine at higher speeds.

[0013] Accordingly, it is an object of the present invention to provide a tufting machine where the gauge elements of the tufting machine are accurately positioned within a modular block assembly.

[0014] Another object of the present invention is to provide in a tufting machine, a system which can facilitate the rapid change over of one or more damaged gauge elements, reducing to a minimum the downtime of the tufting machine.

[0015] Another object of the present invention is to provide in a modular block assembly, a system which can facilitate the rapid change over of individual damaged gauge

elements, reducing the cost of repairing broken gauge elements and removing the need to replace entire modular blocks when a single gauge element becomes damaged.

[0016] Other objects, features, and advantages of the present invention will become apparent from the following description when considered in conjunction with the accompanying drawing wherein like characters of reference designate corresponding parts throughout several views.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] Figure 1 is a fragmentary perspective view of a modular block assembly with single looper modular blocks in place on a gauge bar.

[0018] Figure 2 is an exploded perspective view of the modular block assembly of Figure 1 with modular blocks removed from the gauge bar, and one looper modular block disassembled.

[0019] Figure 3 is a perspective view of the rear surface of a modular block of Figure 1.

[0020] Figure 4 is a fragmentary perspective view of a double looper modular block assembly with modular blocks in place on the gauge bar.

[0021] Figure 5 is an exploded perspective view of the modular block assembly of Figure 4, with modular blocks removed from the gauge bar and one block disassembled.

[0022] Figure 6 is a fragmentary perspective view of a modular needle block assembly with modular blocks in place on a gauge bar.

[0023] Figure 7 is an exploded fragmentary perspective view of the modular needle block assembly of Figure 6 with the modular blocks removed from the gauge bar and one block disassembled.

[0024] Figure 8 is a rear perspective view of a modular block of Figure 6.

[0025] Figure 9 is an exploded perspective view of a modular assembly having a single row of loop-pile hooks held in place by a lateral pin and securing bolts.

[0026] Figure 10A is an exploded view of a modular block having a double row of loop-pile hooks held in place by lateral pins and securing bolts.

[0027] Figure 10B is a top perspective view of the relative positions of the gauge elements, lateral pins and securing bolts of Figure 10A when mounted in the block.

[0028] Figure 10C is a bottom perspective view of the relative positions of the gauge elements, lateral pins and securing bolts of Figure 10A when mounted in the block.

[0029] Figure 10D shows in isolation a side elevation view of the relative positions of a single gauge element, lateral pin and securing bolt when mounted in the block.

[0030] Figure 11A is an exploded view of a modular block having cut-pile hooks with lateral pins, and securing bolts.

[0031] Figure 11B is a side elevation view of the block of Figure 11A.

[0032] Figure 11C is a side elevation view of the relative positions of the gauge elements, lateral pins and securing bolt of Figure 11B when mounted in the block.

[0033] Figures 12A and 12B show the mounting of a series of needle modules according to the present invention to a needle bar.

[0034] Figures 12C and 12D are mirror image perspective exploded views of the needle modules utilized in Figures 12A and B.

[0035] Figure 12E is a sectional view of the needle bar in Figure 12A.

[0036] Figure 12F is a perspective view of the needle modules of Figures 12A through E in assembled and unmounted form.

[0037] Figure 13A is an exploded perspective view of an alternative needle module embodiment with an ovular aperture and round lateral pin.

[0038] Figure 13B is a cross sectional view of the needle module of Figure 13A.

[0039] Figure 14A is an exploded perspective view of an alternative needle module embodiment having a round aperture and utilizing a rectangular lateral pin and flat head securing screws.

[0040] Figure 14B is a cross sectional view of the module of figure 14A.

[0041] Figures 15A, 15B, and 15D are cross sectional, front, and bottom views of an alternative needle module for use with two mounting screws and a single set pin.

[0042] Figure 15C is a sectional view of dual needle bars having protruding mounting pins intended to be received in an aperture of a gauge block such as depicted in Figure 15A.

[0043] Figure 16A is a side view of an alternative needle block and gauge element configuration using a flat head set screw and round lateral pin and an oval aperture.

[0044] Figure 16B reflects the hook element and lateral pins and set screw of the modular block of 15A in isolation.

[0045] Figure 17A is a front perspective view of a hook block for a dual needle bar tufting machine according to the present invention.

[0046] Figure 17B is an exploded perspective view of the hook block of Figure 17A.

[0047] Figure 17C is a rear perspective view of the hook block of Figure 17A.

[0048] Figure 18A is a view of lateral pins and conical set screw utilized to position a looper element in isolation from a modular block.

[0049] Figure 18B illustrates the elements of Figure 18A within a modular block according to the present invention.

[0050] Figure 19A is a perspective view of a looper block according to the present invention for a dual needle bar tufting machine.

[0051] Figure 19B is an exploded perspective view of the looper block of Figure 19A.

[0052] Figure 19C is a rear perspective view of the looper block of Figure 19A.

[0053] Figure 20A is a top plan view of a hook that may be used as a gauge element in the modules of the present invention.

[0054] Figure 20B is a side plan view of the hook of Figure 20A.

[0055] Figure 21 is a looper that may be used as a gauge element in the modular blocks of the present invention.

[0056] Figure 22 is an alternative looper design that may be used in the modular blocks of the present invention.

[0057] Figure 23 is a partial sectional view of the business area of a tufting machine.

DETAILED DESCRIPTION

[0058] The present invention is designed for use in tufting machines of the type generally including a needle bar carrying one or more rows of longitudinally spaced needles that are supported and reciprocally driven by a plurality of push rods. In the tufting zone shown in Figure 23, the needles **13** carry yarns **50** which are driven through a backing fabric **114** by the reciprocation of the needles. While penetrating the backing fabric, a plurality of longitudinally spaced hooks **18, 14** cooperate with the needles to seize loops of yarns and thereby form the face of a resulting fabric. In some cases the hooks will cooperate with knives **113** to cut the loops of yarn seized on the hooks and thereby form a cut pile face **146** for the fabric. The present invention is directed to modular units for holding loopers or hooks and for holding needles to facilitate their cooperation during the tufting process.

[0059] Referring in detail to Figure 1, a modular block assembly **5** is illustrated having a single row of gauge elements **10**, in this case loopers, housed in a series of modular blocks **15**. The individual gauge elements **10** are fastened to each block **15** by a lateral pin **20**. As better illustrated in Figure 2, the lateral pin **20** enters the modular block **15** at one of the opposing side surfaces **22a, 22b**. The gauge bar **25** and guide bar **30** are used in concert to position the modular blocks **15**

relative to one another. The guide bar **30** extends laterally through channel **35** substantially the entire length of the gauge bar **25**. The tab breaks **115** of the modular blocks **15** engage with guide bar **30** as shown in Figure 3, to vertically align the individual blocks **15** in the modular block assembly 5.

[0060] Figure 2 illustrates a portion of the modular block assembly **5** with the blocks **15** detached from the gauge bar **25**. The gauge bar **25** has a plurality of vertical recesses **40**. The recesses **40** are crossed by lateral channel **35** so that guide bar **30** fits between the gauge bar **25** and the rear surfaces **45** of the modular blocks **15**. Guide bar **30** creates upper face **31** and lower face **32** which are normal to the side walls of recesses **40**. When tab breaks **115** of modular blocks **15** engage these faces **31**, **32**, the faces serve as restraining surfaces to hold blocks **15** in vertical alignment.

[0061] One modular block **15** in Figure 2 is disassembled and removed from the gauge bar **25** to reveal spaced parallel slots **50** divided by vertical walls **51** located on the front surface **55** of the block for receiving the proximal ends **75** of the gauge elements **10**. The illustrated proximal ends **75** of the gauge elements **10** contain apertures such as pinholes **70**. When the gauge elements **10** are positioned in the modular block **15** the pinholes **70** align with apertures formed in side surfaces of the block such as pin opening **85**. Lateral pin **20** is then inserted

through pin opening **85** in one of the opposing side surfaces **22a**, **22b**, and the pinholes **70** for each gauge element **10** to fasten the gauge elements **10** in block **15**.

[0062] In illustrated modular blocks **15** containing only a single row of gauge elements **10**, a tongue portion **60** extends from the rear surface **45** of the modular block **15**. The tongue **60** has an opening, preferably in the form of hole **90**, as shown in Figure 3. When the modular block **15** is positioned on the gauge bar **25**, threaded hole **90** aligns with another hole **100** located in a gauge bar recess **40**. Once a modular block **15** is positioned a securing screw **65** can be inserted through hole **90** and tightened into the hole **100** on the gauge bar **25**. A modular block **15**, once fixed in place by the securing screw **65**, is prevented from lateral and vertical movement. The screw **65** and side walls of vertical recesses **40** resist against horizontal movement while the screw **65** and faces **31**,**32** of the guide bar **30** resist against vertical movement. The fixed position of the blocks **15** insures that the gauge elements **10** remain properly aligned during the tufting process.

[0063] Figure 3 shows the rear surface **45** of a modular block **15** having a single row of gauge elements **10**. On the rear surface **45** is a detent in the form of an elongated tab **110** extending vertically from the top **165** of the block to the bottom of the tongue portion **60** of the block. Tab **110** has a horizontal

break **115** that engages with guide bar **30** to vertically position block **15** on the gauge bar **25**. The walls of break **115** are preferably substantially planar and parallel so that a part of the rectangular cross section of guide bar **30** closely fits within break **115**. The lower segment **120** of the tab contains the opening **90** where the securing screw **65** enters and attaches to a receiving hole **100** in the gauge bar **25**.

[0064] Figure 4 illustrates a section of a modular block assembly **5** with three double gauge element modular blocks **130** mounted on the gauge bar **26**. Each modular block **130** contains two transverse gauge element rows **125**, the forward gauge elements **12** forming a first row **125** and rear gauge elements **11** forming a second row. Modular blocks **130** have two apertures such as pin openings **85a**, **85b** that are spaced apart on the side surfaces **22a**, **22b** of the block **130**. Unlike blocks **15** in Figure 1, a portion of the double gauge modular blocks **130** rests on top of the gauge bar **26** to vertically position blocks **130**. This is accomplished by using a downwardly extending detent such as tongue **60** illustrated near the center of the bottom **135** of blocks **130**.

[0065] Figure 5 shows an exploded view of modular block **130** containing two rows **125** of gauge elements **11**, **12**. The gauge bar **26** in Figure 5 has a plurality of vertical recesses **40**. Vertical recesses **40** receive tongues **60** to horizontally

position blocks **130** along the gauge bar **25**. Vertical positioning is accomplished by resting part of the bottom surface **135** of gauge blocks **130** on the top surface of gauge bar **25**. Modular block **130** in Figure 5 is disassembled and removed from the gauge bar **26** to reveal the spaced parallel slots **50a, 50b** located on the front **55** and rear surface **45** of the block **130** for receiving the proximal ends **77, 78** of the front and rear gauge elements **12, 11**.

[0066] The proximal ends **77, 78** of the gauge elements **12, 11** contain openings such as pin holes **71, 72** which when positioned in slots **50a, 50b** of modular block **130** align with pin openings **85a** or **85b**, respectively. The lateral pins **20a, 20b** are inserted through the pin openings **85a** or **85b** on one of the opposing side surfaces **22a, 22b** and through pin holes **71, 72** in the proximal ends of each gauge element **11, 12** to fasten the gauge elements **11, 12** in the modular block **130**.

[0067] In the illustrated modular blocks **130** the tongue portion **60** of the modular block **130** extends centrally from the bottom surface **135**. Tongue **60** defines an opening (not shown). When modular blocks **130** are positioned on gauge bar **26**, this opening aligns with a threaded receiving hole **100**, located in vertical recesses **40** of gauge bar **26**. Once the modular block **130** is positioned a securing screw **65** can be inserted through the opening in tongue **60** and tightened into threaded receiving

hole **100**. Modular blocks **130**, once fixed in place by securing screws **65**, are prevented from lateral movement by the securing screw **65** and interface of the detent against walls of vertical recesses. Similarly, modular blocks **130** are prevented from vertical movement by securing screw **65** and interface of bottom surface **135** against the top surface **26a** of gauge bar **26**. The fixed position of the block **130** insures that the gauge elements **11, 12** remain properly aligned during the tufting process.

[0068] Referring now to Figure 6, another aspect of the present invention depicts a section of a modular block assembly **5** having a row of gauge elements, in this case needles **13**, housed in clamping modular blocks **140**. Figure 6 shows four clamping modular blocks **140** attached to gauge bar **27**. The clamping modular blocks **140** are positioned such that the lower portion **150** of the block **140** extends beneath the gauge bar **27**. This exposed lower portion **150** contains individual clamping elements, such as screw-pins **145**, shown in Figure 7, that hold the gauge elements **13** in place in the block **140**. The gauge bar **27** has a horizontal shelf portion **27a** and a vertical portion **27b** which join to form an interior right angle into which the blocks **140** are positioned.

[0069] Figure 7 illustrates a portion of a modular block assembly **5** with screw-pin modular blocks **140** detached from the gauge bar **27** and one block **140** disassembled. The gauge bar **27**

has a plurality of vertical recesses **40** on the inner surface of vertical portion **27b** of the gauge bar **27**. As illustrated, the recesses **40** do not extend the entire height of the wall portion **27b** of the gauge bar **27**. Each recess **40** preferably contains a clearance hole **100** which receives a securing screw **65** to attach blocks **140** to the gauge bar **27**. The rear surfaces **45** of modular blocks **140** have a detent such as tab **160** with an opening, such as threaded hole **90** (shown in Figure 8), positioned to align with holes **100**, located in the vertical recesses **40** of gauge bar **27**. Once a modular block **140** is positioned in the interior right angle between the shelf portion **27a** and wall portion **27b**, with tab **160** received in a vertical recess **40**, the securing screw **65** can be inserted through the corresponding hole **100** in the wall portion **27b** into the threaded hole **90** in the tab **160** and tightened to hold the modular block **140** in place. Once fixed in place by securing screw **65**, the modular block **140** is prevented from lateral movement by the action of the tab **160** fitting between the vertical walls of the vertical recess **40**, by the screw **65**. Vertical movement is restrained by action of the screw **65** and the interface of the top surface 165 of block **140** with the bottom of shelf portion **27a** of the gauge bar **27**. The fixed position of the block **140** insures that the gauge elements 10 remain properly aligned during the tufting process.

[0070] Figure 7 also depicts a disassembled clamping modular block **140** thereby revealing the spaced parallel gauge element openings **155** which extend from the top surface **165** to the bottom surface **135** of the block **140**. Openings **155** need not extend completely to the top surface **165** for satisfactory operation, however, it is convenient for manufacture. The individual needles **13** are fastened to the block **140** by dedicated clamps such as screw-pins **145** that fix individual gauge elements **10** within the block **140**. Screw pins **145** enter the block **140** at the rear surface **45** of the block **140** on its lower portion **150**. When the block is attached to the gauge bar **27** the screw-pins **145** remain accessible so that individual gauge elements **10** can be removed and replaced.

[0071] Figure 8 illustrates the top **165** and rear surface **45** of the block **140**. Gauge element openings **155** can be seen on the top surface **165** of the block **140**. A rectangular tab **160** for positioning the block **140** on the gauge bar **27** is located centrally on the rear surface **45** of the block **140**. The rectangular tab **160** defines the opening **90** which aligns with the holes **100** in vertical recesses **40** and with securing screw **65** fixes the block **140** to the gauge bar **27**. Openings **170** for screw pins **145** are located horizontally along the lower portion **150** of block **140**.

[0072] Referring now to Figure 9, a preferred embodiment of the present invention depicts a modular block assembly **5** having a single row of gauge elements, in this case loop pile hooks **10**, housed in a single gauge modular block **15**. The modular block **15** may be mounted and attached to the gauge bar **25** with securing screw **65** extending through the block **15** into the gauge bar **25**. The gauge elements **10** are inserted in and removably secured to the block **15** by use of lateral pin **20**. The lateral pin **20** may be divided into two or more sections, or be formed of somewhat malleable material, to compensate for various differences in the heights of the gauging elements **10**.

[0073] Unlike the previous embodiments, the illustrated lateral pin **20** does not extend through openings in the gauge elements **10**, but merely abuts proximal ends of gauge elements **10** so that the gauge elements **10** are resting on the lateral pin **20**. The lateral pin **20** is then biased against the gauging elements **10** by a clamp such as securing bolt **38** received in threaded opening **39** on the top surface **165** of modular block **15**. Tightening securing bolts **38** biases the lateral pin **20** against the gauging elements **10**. In a preferred embodiment the lateral pin **20** is made of a soft metal such as brass so that when urged by the securing bolt **38**, the lateral pin **20** deforms slightly and compresses within channels **79** of individual gauge elements **10**. As a result of the clamp, the lateral pin **20** is held in place

preventing lateral movement of the pin **20** into or out of the block **15**.

[0074] Due to differences in the width of the proximal ends **75** and channels **79** of the various gauge elements **10**, varying amounts of pressure are required along the length of pin **20** to sufficiently compress and restrain the gauge elements in a fixed position. Thus a preferred construction divides the pin **20** into segments to prevent the necessity of compressing a single pin **20** into all the gauge elements **10**.

[0075] This method of securing gauging elements to a block may also be employed for double gauge modular blocks **130** as seen in Figure 10A. Rear and forward gauging elements **11** and **12** are arranged in parallel transverse rows on block **130**. The rear row of gauging elements **11** is held in position by rear lateral pin **20a**. Pin **20a** is biased against the rear gauging elements **11** by securing bolts **38a** which are received by threaded openings **39a**. Likewise, the forward gauging elements **12** are held in place by forward lateral pin **20b** biased against the forward gauging elements **12** by securing bolts **38b** which are received by threaded openings **39b**.

[0076] In Figures 10B and 10C, the gauge elements **11, 12** are shown with lateral pins **20a, 20b** and securing bolts as they would be positioned in blocks **130**, however, the blocks are not shown. Of particular interest is the conical point **89** of

securing bolts **38a**, **38b**. The conical points **89** are aligned alightly off center of lateral pins **20a**, **20b**, so that the side wall rather than the vertice of the conical point makes contact with the pins **20a**, **20b**. This causes a wedge like or camming effect to pressure pins **20a**, **20b** against gauge elements **11**, **12**. When securing bolts **38a**, **38b** utilize camming action rather than mere frontal clamping pressure as would typically be the case if the bolts had flat ends, the bolts **38a**, **38b** will continue to function even when wear and operating stresses have introduced some play between the threads of the bolts **38a**, **38b** and their openings **38a**, **39b**.

[0077] Figure 10D shows a single securing bolt **38a** with conical point **89** applying camming type pressure against lateral pin **20a** which is engaged in channel **79** of rear gauge element **11**. The modular block **130** that would hold these components is not shown so that the interaction of the gauge element, lateral pin **20a** and securing bolt **38a** can be clearly illustrated.

[0078] An additional embodiment of the invention is illustrated in Figure 11A. The gauge elements, in this case cut-pile loopers **14**, **18** are shown removed from block **15**. When mounted in block **15**, the gauge elements **14**, **18** fit between lateral bracing pins **16a**, **16b** and secured lateral pin **20**. The bracing pins **16a**, **16b**, are slidably press fit within the block **15** and then gauge elements **14**, **18** are positioned. Bracing pins

16a, **16b** preferably fit in channels **79a**, **79b** (shown in Figure 11C) of gauge elements **14**, **18**. Pin **20** is also biased against the gauge elements **14**, **18** by a clamping device such as securing bolts **38** proceeding through threaded openings **39** to engage the pin **20**. Once the gauge elements **14**, **18** are placed in the block **15** and the bracing pins **16a**, **16b** are positioned in channels **79a**, **79b** of those gauge elements **14**, **18** and lateral pin **20** is in place in block **15**, the securing bolts **38** are tightened to bias the securing pin **20** against the gauge elements **14**, **18**.

[0079] Figure 11A shows a series of four securing bolts **38**. In a preferred embodiment, each securing bolt **38** contacts a dedicated segment of the pin **20**. Pin **20** may be made of a malleable metal such as brass and either cut or scored to create segments. Thus, pin **20** may be comprised of four separate pieces. The bolts **38** are sufficiently spaced across the block **15** so that each securing bolt **38** can contact a segment of the securing pin **20** and thereby bias between about two and about four individual gauge elements **14**, **18**. Even without cutting or scoring, the use of a pin of malleable material permits securing bolts to bias multiple gauge elements, which is particularly beneficial in avoiding the need to have apertures for bolts near the edges of the blocks.

[0080] Figures 11B and 11C are side plan views of the modular block **15** and cut pile loopers **14**, **18** of Figure 11A,

however, Figure 11C shows the gauge elements **14, 18**, lateral pins **16a, 16b, 20**, and securing bolts **38** without the modular block **15**. It can be seen that cut pile loopers **14, 18** are designed to engage with rear and front rows of needles respectively, although a single length of looper could be used if only one row of needles was to be used to create cut pile tufts. As best seen in Figure 11B, the side wall of conical point **89** exerts camming pressure against lateral pin **20**. Lateral pin **20** in turn engages with the proximal ends of gauge elements **14, 18**. Figure 11C shows that lateral pins **16a, 16b** and **20** are advantageously set in channels **79a, 79b, 79** formed in the proximal ends of the gauge elements **14, 18**.

[0081] Turning to Figure 12A, a series of modular needle blocks **240** are mounted to staggered needle bar **227**. Each needle block **240** is held in place by one securing screw **265** and two pins **275**, each of which penetrates both the needle block **240** and needle bar **227**. It will be noted the alignment of the pins **275** and screw **265** is one fourth of the gauge of the block **240** (or one-sixteenth of an inch for a one-fourth inch gauge block) to the left of center of block **240**. This results in a one-fourth gauge space **271** at the end of needle bar **227** for the needle blocks **240** aligned on the front of the bar. However, for the needle blocks **240** aligned on the rear of the bar it results in a one fourth guage space **272** where the needle block **240** overruns

the end of needle bar **227**. In this fashion, the needles of the front needle blocks are offset a total of one half guage from the needles of the rear needle blocks, thereby permitting identical needle blocks to be utilized on both sides of the needle bar while providing a staggered orientation for the two rows of needles. In this fashion, a composite one-eighth gauge staggered needle bar is formed from the front and back rows of one-fourth gauge needles.

[0082] More clearly shown in Figures 12C through 12F, the needle blocks **240** of the illustrated embodiment possess two openings **276** to receive pins **275** and a threaded aperture **241** to receive screws **265**. In addition, blocks **240** have plurality of threaded apertures to receive preferably flat headed set screws **245** which exert pressure against lateral pin **220**. The shaft end **213A** of needles **213** is placed through lower aperture **212** across channel **221** and into upper aperture **211**. The screws **245** exert pressure against rectangular, and preferably approximately square lateral pin **220** which in turn presses on needle shafts **213A** within apertures **211, 212** and securely holds needles **213** in place. The use of rectangular channel **221** to position lateral pin **220** is preferred for manufacturing purposes relative to of the drilling of a round or oval aperture laterally through block **240**. To realize the benefits of manufacture, it is not necessary that channel **221** be perfectly rectangular, only that

its upper and lower surfaces be substantially parallel to one another.

[0083] In the alternative embodiment depicted in Figures 13A and 13B, an oval opening **321** proceeds laterally through block **340** and conical set screws **345** are utilized to press round lateral pin **320** against upper needle shafts of **313A** while passing from bottom to top of block **340** through apertures **311**. The difficulty of forming true apertures **321** rather than channels **221** with an open side, as depicted in connection with Figure 12, as well as the difficulty of utilizing a conical set screw with a range of needle shaft sizes makes the construction of Figure 13 slightly less preferable.

[0084] As shown in Figure 14A a round hole may alternatively be utilized with a square or rectangular lateral pin **220**. When a square or rectangular pin is used, a flat headed set screws **245** are advantageously utilized to press pin **220** against upper needle shaft portions **313A**. Alternatively, a round pin may also be placed in aperture **322** with acceptable results.

[0085] In the alternative embodiments of Figures 15A through 15D, a block **440** is provided for use with two securing screws **465** and one pin **475** which is received in aperture **476**. The pin, which is only optional in the case where a plurality of securing screws are available, extends from needle gauge bar **427** into aperture **476** of block **440**. It is to be understood in reference

to needle blocks **440, 340, 240**, the aperture **441, 341, 241** is preferably slightly larger than securing screw **465, 365, 265** so that the threads of the screw do not bind with the block and the screw head can exert camming action against the block toward the gauge bar **427, 327, 227**. When it becomes necessary to remove the block **440, 340, 240** from the gauge bar, the block may be removed by hand if it does not bind, or if tightly secured by action of pins **475, 375, 275**, then a removal bolt having larger threads (not shown) may be screwed into threaded apertures **441, 341, 241** to provide leverage for removal of the block. The threaded section of the larger removal bolt should not even fit into the threaded openings of the gauge bar.

[0086] Figures 16A and 16B illustrate another modular block **540** and the positioning of hook element **14** by pins **516a** and **516b**, lateral pin **520** and set screws **45**. The bottom of gauge element **14** is angled at approximately 7.5 degrees reflected by θ in Figure 16B. This provides an acceptable angle for pressure by lateral pin **520** to securely hold hook element **14** in place.

[0087] Figure 17A through C depict an entire block **540** with both short and long hooks **14, 18** in exploded and front and rear perspective views. It will be appreciated that the blocks **540** may be used either with all hooks of one length in the case of a single row of needles, or with hooks of alternating lengths in

the event that yarns are to be seized from two rows of needles, as might be the case on a staggered needle bar.

[0088] Figures 18A and B disclose another configuration of looper gauge elements **10** utilized in block **640** having lateral pin **620** pressed by conical screw **645** against the angled rear of gauge element **10**. Preferably the angle of the gauge element varies from a vertical by approximately 7.5 degrees as represented in θ in Figure 18A. In all events, the angle of the gauge element should be between approximately 5 to 15 degrees.

[0089] Figures 19A through C reflect block **640** utilized with rows of alternating looper gauge elements **10, 12**. It will be understood that block **640** may be utilized either with the alternating gauge elements in the case of cooperation with two rows of needles or with a single type of gauge element if the block is to be utilized to seize yarns only from a single row of needles.

[0090] Figures 20 through 22 depict the outlines of gauge elements as well as the approximate 7.5 degree variation represented by angle θ in each instance which permits a lateral pin **20** to securely hold the gauge element in place within a module according to the invention.

[0091] A further substantial benefit of hook and looper modular gauge element assemblies according to the present invention it is their relative light weight. By utilizing

aluminum or other light weight material for modular blocks **240, 340, 440, 540, 640** a substantial weight reduction, on the order of fifty pounds on a broadloom tufting machine, is realized over traditional steel looper and hook assemblies. Furthermore, when other elements of the looper assembly as shown in Figure 23 are also constructed of light weight materials, approximately 40% or over 200 pounds of the looper assembly can be removed from the tufting machine. Thus the modules **240** as well as link arms **137**, rocker arms **139**, looper arms **134** are all advantageously made of light weight materials such as aluminum alloy. The weights of knife shaft **44** and looper shaft **136** are not so critical as they rotate in place without substantial axial displacement. The resulting reduction of weight in the looper apparatus of the tufting machines substantially reduces vibration and results in smoother operation at high speeds. In addition, it is believed the use of aluminum blocks **240, 340, 440, 540 and 640** assist in conducting heat away from the gauge bars and thereby minimizes thermal expansion of gauge bars and keeps the gauge elements of the tufting machine in better alignment throughout its operation.

[0092] Although preferred embodiments of the present invention have been disclosed in detail herein, it will be understood that various substitutions and modifications may be made to the disclosed embodiment described herein without

departing from the scope and spirit of the present invention as recited in the appended claims.